

Convert 14500 mg to kg

$$\text{mg} = 10^{-3} \text{g}$$

$$\text{kg} = 10^3 \text{g}$$

$$14500 \text{mg} \times \frac{10^{-3} \text{g}}{\text{mg}} \times \frac{\text{kg}}{10^3 \text{g}} = \boxed{0,0145 \text{kg}}$$

Convert 0.147 cm^2 to m^2

$$1 \text{ cm} = 10^{-2} \text{ m}$$

$$0.147 \text{ cm}^2 \times \frac{10^{-2} \text{ m}}{\text{cm}} \times \frac{10^{-2} \text{ m}}{\text{cm}} = \boxed{1,47 \times 10^{-5} \text{ m}^2}$$

(0.0000147 m^2)

We have to convert both parts of this squared unit, so we apply our conversion factor TWICE!

$$1 \text{ cm}^2 = \underbrace{1 \text{ cm}} \times \underbrace{1 \text{ cm}}$$

Must convert BOTH!

8.45 kg to μg $\mu\text{g} = 10^{-6}\text{g}$ $\text{kg} = 10^3\text{g}$

$$8.45 \cancel{\text{kg}} \times \frac{10^3 \cancel{\text{g}}}{\cancel{\text{kg}}} \times \frac{\mu\text{g}}{10^{-6} \cancel{\text{g}}} = \boxed{8450000000 \mu\text{g}}$$
$$\boxed{8.45 \times 10^9 \mu\text{g}}$$

88100 kHz to MHz $\text{kHz} = 10^3\text{Hz}$ $\text{MHz} = 10^6\text{Hz}$

$$88100 \cancel{\text{kHz}} \times \frac{10^3 \cancel{\text{Hz}}}{\cancel{\text{kHz}}} \times \frac{\text{MHz}}{10^6 \cancel{\text{Hz}}} = \boxed{88.1 \text{ MHz}}$$

Convert 38.47 in to m, assuming 2.54 cm = 1 in

$$2.54 \text{ cm} = 1 \text{ in}$$

$$\text{cm} = 10^{-2} \text{ m}$$

$$38.47 \text{ in} \times \frac{2.54 \text{ cm}}{1 \text{ in}} \times \frac{10^{-2} \text{ m}}{\text{cm}} = 0.97771 \text{ m}$$

Accuracy and Precision

- two related concepts that you must understand when working with measured numbers!

Accuracy

- how close a measured number is to the CORRECT (or "true") value of what you are measuring
- "Is it right?"
- checked by comparing measurements against a STANDARD (a substance or object with known properties)

Precision

- how close a SET of measured numbers are to EACH OTHER
- "Can I reproduce this?"
- checked by repeated measurements

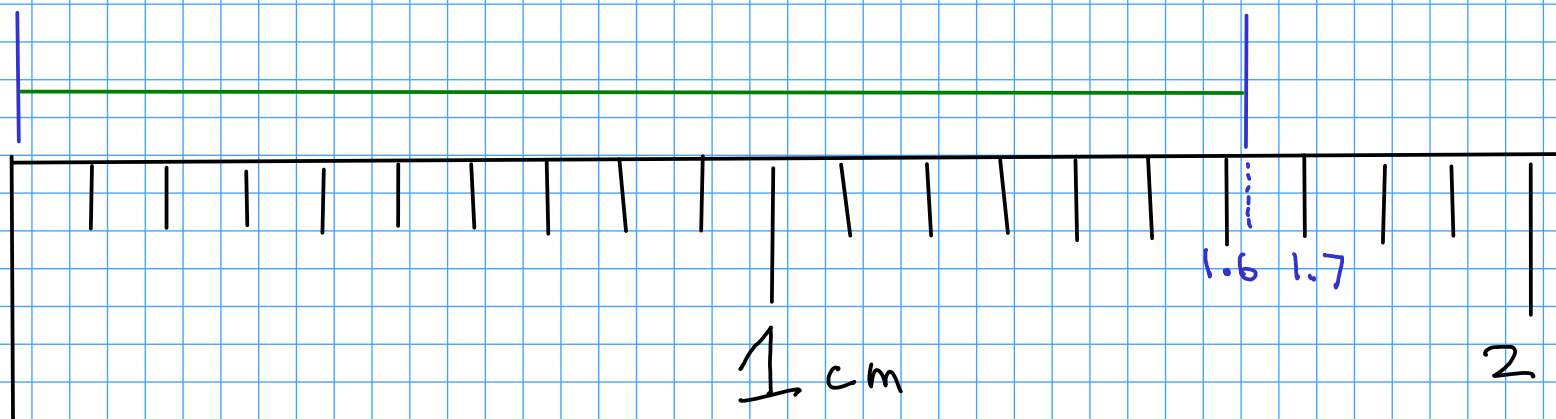
More on precision

Every measurement contains some amount of ERROR, or some amount of deviation from the true value of what is being measured.

RANDOM ERROR is the variability in a measurement that cannot be traced back to a single cause. Random errors cause measurements to fluctuate around the true value, but can be averaged out given enough measurements.

When reporting measurements, we want to indicate how much random error we think is present. How?

Form: $X.XX$ cm



How long is the green line?

Write your answer on the sheet, then fold the sheet in half and pass it up to the front!

Our classroom experiment: Results

After throwing away obvious mistakes in reading the scale, we had:

Value	# students
1,61	1
1,62	14
1,63	15
1,67	1
	.

Overall average

$$\begin{aligned}\bar{X} &= 1.62613 \text{ cm} \\ &= \underbrace{1,6,3}_{\text{CERTAIN DIGITS}} \pm \underbrace{0.01}_{\text{UNCERTAIN DIGITS}} \text{ cm}\end{aligned}$$

CERTAIN DIGITS: Appear in nearly all repeats of the measurement

UNCERTAIN DIGITS: Vary.. Variation caused by estimation or other sources of random error.

31 total measurements

When reading measurements from a scale, record all CERTAIN digits and one UNCERTAIN (or estimated) digit.

Significant figures

SIGNIFICANT FIGURES are a way to indicate the amount of uncertainty in a measurement.

The significant figures in a measurement are all of the CERTAIN DIGITS plus one and only one UNCERTAIN (or estimated) DIGIT

Example:

From our classroom experiment,

1.63 cm

We estimated the last digit, it's uncertain

These digits were obtained in all measurements. They are certain

THIS MEASUREMENT HAS "THREE SIGNIFICANT FIGURES"!

Determining significant figures

When you read a measurement that someone has written using the significant figures convention, you can tell how precisely that measurement was made.

$$1.47\text{\textcircled{3}} \text{ g} \pm 0.001$$

This was measured to the nearest ± 0.001 g
The last digit is always **UNCERTAIN** (or estimated)

$$2\text{\textcircled{1}} \text{ m} \pm 1$$

Some other examples

$$3.2076 \text{ g} \pm 0.0001 \text{ g}$$

↑ uncertain

$$27.3 \text{ m} \pm 0.1 \text{ m}$$

↑ uncertain

$$37.2\text{\textcircled{6}} \text{ kg} \pm 0.01$$

A small problem

The number ZERO has several uses. It may be a measured number, but it may also be a mere "placeholder" that wasn't measured at all!

So how do we tell a measured zero from a placeholder? There are a few ways:

1: BEGINNING ZEROS: Beginning zeros are NEVER considered significant.

0.15 g
This zero merely indicates that there is a decimal point coming up!

0.015 m (1.5 cm)
These zeros are placeholders. They'll disappear if you change the UNITS of this number!

0.00063 mm
None of these zeros are considered significant